TASK 2

ARAC ESHWG REPORT 25X899

1 - What is underlying safety issue addressed by the FAR/JAR?

JAR 25X899 addresses the requirement for electrical bonding and protection of the aircraft from the effects of lightning and static electricity.

2 - What are the current FAR and JAR standards?

Current FAR text:

FAR Text does not exist

Current JAR text:

JAR 25X899: Electrical Bonding and protection against lightning and static electricity

The electrical bonding and protection against Lightning and Static Electricity systems must be such as to:

(a) Protect the aeroplane, including its systems and equipment, against the dangerous effects of lightning discharges;
(b) Prevent dangerous accumulation of Electro-static charge;
(c) Minimize the risk of electrical shock to crew, passengers and servicing personnel and also to maintenance personnel using normal precaution, from the electricity supply and distribution system;
(d) Provide an adequate electrical return path under both normal and fault condition, on aeroplanes having earthed electrical systems;
(e) Reduce to an acceptable level interference from these sources with the function of essential electrically powered or signaled services.

3 - What are the differences in the standards and what do these differences result in?

The JAR 25X899 requirement for electrical bonding and protection from the effects of lightning and static electricity are stated explicitly in the JAR text, with specific Interpretative Material and Acceptable Means of Compliance given in ACJ 25X899.

The FAR provides some equivalent requirements in FAR paragraphs 25.581, 25.954 and 25.1316 for protection from lightning discharges. However, JAR 25X899 and its related ACJ 25X899 have additional requirements relating to protection from electrical shock, fuel vapor ignition or electromagnetic interference caused by accumulation of electrostatic charge and for aircraft having a ground return path through structure. Electrical bonding must be adequate for both normal and fault conditions.

JAR 25X899 and its associated ACJ, as it is currently written, duplicates some of the requirements found in other JAR paragraphs and specifications given for use in assessing adequacy of protection from lightning discharges are out of date.

The differences in the standards of the FAR and JAR result in inconsistency and confusion because compliance for features relating to bonding and protection from effects of lightning discharges and accumulation of static electricity must be shown using different paragraphs in each standard.

4 - What, if any, are the differences in the means of compliance?

For JAR 25X899, compliance requirements are given by ACJ 25X899 and interim policies. In the FAR, there are other paragraphs that are applicable to much of this subject matter but there are no specific guidelines given to show compliance.

5 – What is the proposed action?

The ESHWG recommends that the JAR 25X899 should be revised as follows:

"Note add references to ACJ 25.899" or to FAR

(1) Delete JAR 25X899(a) because it is addressed in FAR/JAR paragraphs 25.581,25.954 and 25.1316.
(2) The intent of JAR 25X899(b) should be retained to address protection from the accumulation of static electricity, but it should be rewritten to clearly state the requirement.
(3) Delete JAR 25X899(c) because it is addressed in JAR 25X1360(a), which will also be adopted into the FAR as part of this harmonization project.
(4) Move the requirement of JAR 25X899(d) to a new FAR/JAR sub-paragraph 25.1353(e). This will place this requirement with related requirements and provide for improved consistency and coordination of both FAR and JAR.
(5) Delete JAR 25X899(e) because it is addressed in FAR/JAR 25.1353(a) and JAR 25.1431(d). JAR 25.1431(d) will also be adopted into the FAR as part of this harmonization project.
(6) Modify ACJ 25X899 to provide specific Interpretative Material and Acceptable Means of Compliance for the new FAR/JAR 25.899, which will address bonding and static electricity. This new ACJ should also reference and be applicable to the other paragraphs that relate to bonding and static electricity.
(7) There is a reference to ACJ 25X899 in JAR 25.581(a), which should be revised to refer to the new ACJ 25.899. Also, for FAR 25.581(a), a reference to FAR 25.899 or a new AC should be added.

6 - What should the harmonized standard be?

The following FAR/JAR paragraphs would be affected by the proposed harmonized standard:

FAR/JAR 25.899 Electrical Bonding and Protection Against Static Electricity
For JAR See ACJ 25.899)
(Note: The FAR will not reference the AC)

(a) Electrical bonding and protection against static electricity must be designed to minimise accumulation of electrostatic charge, which would cause:

(1) Human injury from electrical shock,

(2) Ignition of flammable vapours, or

(3) Interference with installed electrical/electronic equipment.

(b) Compliance with sub-paragraph (a) of this paragraph may be shown by

(1) Bonding the components properly to the airframe, or

(2) Incorporating other acceptable means to dissipate the static charge so as not to endanger the aeroplane, personnel or operation of the installed electrical/electronic systems.

FAR/JAR 25.1353 Electrical equipment and installations

(e) Electrical bonding must provide an adequate electrical return path under both normal and fault conditions, on aeroplanes having earthed electrical systems (see FAR/JAR 25.899).

FAR/JAR 25.1360 Precautions against injury

(a) Shock. The electrical system must be designed to minimise the risk of electric shock to crew, passengers and servicing personnel and also to maintenance personnel using normal precautions.
(See ACJ 25.1360(a) and FAR/JAR 25.899.)

(Note: The FAR will not reference the AC)

7 - How does this proposed standard address the underlying safety issue (identified under #1?

The proposed standard addresses the underlying safety issue by highlighting the requirement of electrical bonding and static electricity as a full aircraft requirement and by placing cross references within the specific section which deals with electrical systems and lightning protection.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The proposed standard increases the level of safety by decreasing the confusion of redundant requirements and ensuring the requirement of electrical bonding and static protection is addressed as a full aircraft requirement.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The proposed standard maintains the same level of safety because it is believed that the current industry practice is in compliance with the proposed standard.

10 - What other options have been considered and why were they not selected?

The following options were considered:

1) To adopt the current JAR 25X899; This option was not selected because the current JAR 25X899 is redundant to several other JAR/FAR; Is not specific (i.e. vague) in regard to static electricity requirements and is not addressed properly in the electrical section of the FAR/JAR;

2) To delete the current JAR 25X899: This option was not selected because it was felt that the requirement to address electrical bonding and static electricity protection was needed to ensure the safety of the aircraft

11 - Who would be affected by the proposed change?

Airplane manufacturers will be affected by the proposed change by requiring compliance to the new sections proposed.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble?

There is no current advisory material that is proposed to be included in the rule.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

The advisory material relating to bonding and static electricity protection is proposed to be a new AC/ACJ as shown below and should be published concurrently with the rule:

AC/ACJ 25.899 Electrical Bonding and Protection Against Static Electricity
See FAR/JAR 25.899

1 Protection against Lightning Discharges.

Reference: FAR/JAR 25.581; 25.954; 25.1316 and associated Advisory Material

2 Characteristics of Lightning Discharges

Reference Advisory Circular 20.XXX: Lightning Environment and Associated Test Waveforms.

3 Protection against the Accumulation of Static Charges

3.1 General. All items, which by the accumulation and discharge of static charges may cause a danger of electrical shock, ignition of flammable vapours or interference with essential equipment (e.g. radio communications and navigational aids) should be adequately bonded to the main earth systems.

3.2 Intermittent Contact. Design should ensure that no fortuitous intermittent contact can occur between metallic and/or metallized parts.

3.3 High Pressure Refuelling and Fuel Transfer. Where provision is made for high pressure refuelling and/or for high rates of fuel transfer it should be established, by test, or by consultation with the appropriate fuel manufacturers, that dangerously high voltages will not be induced within the fuel system. If compliance with this requirement involves any restriction on the types of fuel to be used or on the use of additives, this should be established.

3.3.1 With standard refuelling equipment and standard aircraft turbine fuels, voltages high enough to cause sparking may be induced between the surface of the fuel and the metal parts of the tank at refuelling rates above approximately 250 gal/min. These induced voltages may be increased by the presence of additives and contaminants (e.g. anti-corrosion inhibitors, lubricating oil, free water), and by splashing or spraying of the fuel in the tank.

3.3.2 The static charge can be reduced as follows:

a. By means taken in the refuelling equipment such as increasing the diameter of refuelling lines and designing filters to give the minimum of electrostatic charging, or

b. By changing the electrical properties of the fuel by the use of anti-static additives and thus reducing the accumulation of static charge in the tank to negligible amount.

3.3.3 The critical refueling rates are related to the aeroplane refueling installations, and the designer should seek the advice of fuel suppliers on this problem.

4. Primary and Secondary Bonding Paths
(Reference 25.581; 25.954; 25.1316; 25.1353; 25.1360;)

4.1 Primary bonding paths are those paths, which are required to carry lightning discharge currents. These paths should be of as low an electrical impedance as is practicable. Secondary bonding paths are those paths provided for other forms of bonding.

4.2 Where additional conductors are required to provide or supplement the inherent primary bonding paths provided by the structure or equipment, then the cross-sectional area of such primary conductors made from copper should be not less than 3 mm2 except that, where a single conductor is likely to carry the whole discharge from an isolated section, the cross-sectional area would be not less than 6 mm2. Aluminum primary conductors should have a cross-sectional area giving an equivalent surge carrying capacity.

4.3 Primary bonding paths should be used for -
a. Connecting together the main earths of separable major components which may carry lightning discharges,
b. Connecting engines to the main earth,
c. Connecting to the main earth all metal parts presenting a surface on or outside of the external surface of the aeroplane, and
d. Conductors on external non-metallic parts.

4.4 Where additional conductors are required to provide or supplement the inherent secondary bonding paths provided by the structure or equipment then the cross-sectional area of such secondary conductors made from copper should be not less than 1 mm2. Where a single wire is used its size should be not less than 1·2 mm diameter.

5 Resistance and Continuity Measurements. Measurements should be made to determine the efficacy of the bonding and connection between at least the following:

5.1 Primary Bonding Paths.

5.1.1 The extremities of the fixed portions of the aeroplane and such fixed external panels and components where the method of construction and/or assembly leads to doubt as to the repeatability of the bond, e.g. removable panels.
5.1.2 The engines and the main aeroplane earth.
5.1.3 External movable metal surfaces or components and the main aeroplane earth.
5.1.4 The bonding conductors of external non-metallic parts and the main aeroplane earth.
5.1.5 Internal components for which a primary bond is specified and the main aeroplane earth.

5.2 Secondary Bonding Paths.

5.2.1 Metallic parts, normally in contact with flammable fluids, and the main aeroplane earth.
5.2.2 Isolated conducting parts subject to appreciable electrostatic charging and the main aeroplane earth.
5.2.3 Electrical panels and other equipment accessible to the occupants of the aeroplane and the main aeroplane earth.
5.2.4 Earth connections, which normally carry the main electrical supply and the main aeroplane earth. The test on these connections should be such as to ensure that the connections can carry, without risk of fire or damage to the bond, or excessive volt drop, such continuous normal currents and intermittent fault currents as are applicable.
5.2.5 Electrical and electronic equipment and the aeroplane main earth, where applicable, and as specified by the aeroplane constructor.

5.2.6 Static discharger wicks and the main aeroplane structure.

6 Electrical Properties of Composite Structure

6.1 In the case of lightning protection, for the partial conductors the method of surface protection will vary with the criticality of the structure in question. Deterioration of the means of protection or possible hidden damage to the material which may affect its structural integrity, need to be considered. While such materials provide a measure of electro-magnetic screening, the need for additional measures will be a function of the location of the material in relation to critical equipment and wiring in the aircraft. Particular attention will also have to be given to the protection required near fuel systems - e.g. fuel tanks. For non-conducting materials which have no intrinsic lightning protection or screening properties, the measures taken will again depend on the relative locations of the material and critical systems or fuel and the possible loss of the components due to internal air pressures in the event of a strike.

6.2 The partial conducting materials should present no problem in dissipating P-static but problems can arise with the non-conductors. Depending upon the location of the material, protection may be required.

6.3 Electrical currents, other than lightning, can flow in some partial conducting materials and means may be required to limit this by provision of alternative current paths if the effect of large voltage drop is important or if such currents can damage the material.

6.4 Particular care has to be taken that all joints, permanent and temporary, are capable of carrying any currents which may flow particularly those resulting from lightning strikes. Structural damage and loss of screening capabilities may occur if these are not adequately controlled.

6.5 The adequacy of the material in supplying a ground plane for antenna may have to be considered. Again it will vary with the material and the radio frequency of the system.

14 - How does the proposed standard compare to the current ICAO standard?

The proposal is in line with ICAO standards

15 - Does the proposed standard affect other HWG's?

No

16 - What is the cost impact of complying with the proposed standard?

The cost impact of complying with the proposed standard should be insignificant due to the fact that current industry standards result in compliance with this proposed change.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes. In addition, the ESHWG would like to review the draft advisory material.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain.

The "Fast Track" process is appropriate for this rulemaking. All affected sections are under the control of this working group.